Regarding NOI on ET Docket 03-104, Broadband Power Line communications systems:

I am currently, and for the past 30+ years, have been licensed as an Amateur Extra Class amateur radio operator (call sign N2YK) and have been continuously licensed as an amateur radio operator in the United States for over 40 years. While it was relevant, I also held a First Class Radiotelephone License. I am educated in electrical engineering and have practiced in that field for 32 years. From 1978 until 2002, I was employed at AT&T Bell Laboratories, later AT&T Labs – Research, where my recent work involved investigations into multicarrier communications technology for wireless communications, in particular, Orthogonal Frequency Division Multiplexing – OFDM, the same technologies that are used for Digital Subscriber Loop (DSL) over telephone lines and are being discussed for Broadband Power Line (BPL). I am currently Distinguished Service Professor of Electrical and Computer Engineering at Stevens Institute of Technology in Hoboken, New Jersey, the school where I received my undergraduate and graduate engineering degrees. I am also Founder and Chief Technology Officer of Novidesic Communications, LLC, a communications technology consulting company incorporated in the State of New Jersey.

I believe that the development of BPL and related technologies is an inevitable outcome of the need for ubiquitous, cost effective, broadband communications that cannot be fully addressed by existing optical, cable, and DSL technologies, particularly in rural areas. While I am a satisfied user of Comcast's broadband cable data services and a Comcast stockholder, I believe that the ready availability of competing alternative technologies will increase the choices available to consumers and businesses and drive down the cost of access.

That being said, I do not believe that BPL services are a panacea but, if not properly designed and regulated, are very likely to create serious and irreparable harm to MF and HF communications. To illustrate the issue: in the late 1960s, when I was an undergraduate at Stevens, the school had a carrier current AM radio station on campus. Despite attempts to comply with FCC limits on radiated emissions from that system, the power line conducted signals inadvertently leaked into the Hoboken fire alarm circuits. This accidental, uncontrolled distribution of signals through other circuits led to reception of the campus radio station in Manhattan, several miles across the Hudson River, probably including the FCC office that existed in lower Manhattan before the World Trade Center was built. In such a case, identification of the unintended radiation was probably straightforward – the station broadcast its identity and affiliation regularly and in clear language.

If a BPL system today similarly leaked energy into unexpected distribution circuits, it would be a far more difficult task for a user receiving the interference to identify its source – efficiently coded multicarrier communications will likely appear to be rather noise-like, making it quite difficult for the unintended victim to decode the transmissions. Further, as a multiple access communications system, it is very likely that some form of encryption would be used on the channel, rendering the signal even more noise-like and, if designed properly, making it impossible to identify the content or source of the interference. It is quite likely that most users would not even realize why their communications was degraded – the noise-like interference would appear to be just changes in the background noise level and might be chalked up to a failing receiver. Continually shifting loads on the power line would likely change the frequency response of the channel and cause the BPL system to adjust the energy loading on various subchannels, making the interference time varying and even harder to track down.

Similar issues exist for DSL, but on a ***far*** smaller scale. Since DSL links operate in the MF and/or HF spectrum, they, too, are prone to unanticipated radiation. The issue is far less for DSL than it is likely to be for BPL, since the copper telephone plant is twisted pair. As a simple examination of the physics of radiating signals from twisted pair would show, with a close spacing between opposite polarities, the radiated field is nearly cancelled. Further, with a reasonable twist to the wires, the effective size of a radiating loop is additionally reduced in length. Thus, we may have a series of alternating loops that are one or two millimeters wide and several millimeters long, followed several millimeters later with an opposite and counterbalancing loop. Thirdly, for all installations that carry telephone loops and power distribution on the same overhead distribution, the telephone wiring is closer to the ground, minimizing its potential for long distance radiation.

In contrast, there is no twisted wire for power distribution. Opposite polarities are a meter or more apart with the potential for kilometers of parallel (untwisted) conductors. The effective size of such a radiating loop is likely to be measured in square kilometers, rather than square millimeters. And, because the transmission line is not twisted, there is no nearby canceling loop nearby. This makes an MF or HF antenna that most amateur radio operators could only dream of. Finally, the elevation of this enormous radiating loop is likely to be almost double that of the miniscule DSL antenna. For many communities, even where the telephone plant is underground, the power lines are likely to be overhead, exacerbating the problems with BPL.

As further anecdotal evidence of the potential issues, it is well known in the cable industry that ingress noise from HF foreign broadcast stations is a major factor in the use of the HF upstream band for two-way cable systems. The issue here is the large loop antenna created by (a) the overhead feeder cable to a home, (b) protective grounding of the cable at the distribution amplifier on the pole, (c) similar grounding at the residential entrance, and (d) the return path through the ground. This antenna might be 5 meters high and 20 meters long. Combined with less than perfect cable shielding and connections, it allows easy coupling of radiated signals into the cable system. Obviously, a reciprocal effect would exist if the cable system transmitted sufficient HF energy. It is certainly the case that this untuned loop can create a source of interference on the VHF amateur bands. This interference situation exists for cables that are, by design, ***shielded*** against leakage. A power line is not a shielded system. To try to make it so would be prohibitively expensive.

On the other hand, I do not believe that this potentially difficult problem is without a straightforward engineering solution. In “T1E1.4/2000-011R3 & T1E1.4/2000-011R3. VDSL Technical Specifications,” Part 2: Technical Specification for a Single-Carrier Modulation (SCM) Transceiver; Part 3: Technical Specifications for a Multi-Carrier Modulation (MCM) Transceiver, and “Access Transmission systems on metallic access cables;” Very high speed Digital Subscriber Lines (VDSL); Part 2: Transceiver Specification, the potential for interference with MF and HF amateur bands from DSL systems is recognized and dealt with by requiring spectral notches at the VDSL transmitter output at frequencies corresponding to amateur bands. The same flexible nature of a multicarrier system that allows the transceiver to operate with gaps in the spectrum caused by a time dispersive (equivalently, frequency selective) transmission media or by narrow band interference, allows it to deal effectively with intentional blocking of certain bands of frequencies within the emitted bandwidth. This is a simple solution to the problem – prevent the interference at its source (the modem transceiver) rather than trying to deal with at the unintentional receiver where it will be too late, impossible to avoid, and likely indiscernible from thermal noise.

I would encourage the FCC to go forward with plans to allow and regulate BPL systems, but to do so only after proper restriction of the radiated energy from such systems by way of a spectral mask requirement. That spectral mask must include amateur radio frequencies, radio telescope frequencies, standard time and frequency frequencies, shortwave broadcast frequencies, and any other narrowband channels that might intercept harmful interference. While it is not practical to eliminate all potential interference, a reasonable standard should be based on creating a peak power spectral density a few dB above the kTB noise level at a distance of, perhaps, 30 meters from a power line. That is, the BPL system should not generate a noise power spectral density that exceeds the noise floor of a well designed communications receiver as close as one is likely to be operating from an overhead power line at any frequency that the average amateur or shortwave listener is likely to want to receive signals.

From my experiences with related issues and technologies, I feel that this is a serious issue that must be dealt with before impossible to reconcile problems are encountered in the field. I believe that careful consideration of the issues and typical deployment scenarios could lead to a workable solution with adequate performance, but only if the needs of current users of the MF and HF spectrum are taken into account.

Respectively,

Bruce McNair
1 Iron Hill Drive
Holmdel, NJ 07733-1711

bmcnair (at) ieee (dot) org
bmcnair (at) stevens (dash) tech (dot) edu